

# Polarization Studies Group Newsletter

Issue 6

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## News from Advanced Photon Source Sector 4

Application deadline for beamtime is **November 7** for Jan.-Apr. cycle in 2004. If you are interested in applying for beamtime, or developing a collaboration with sector 4 staff, visit Advanced Photon Source website [www.aps.anl.gov](http://www.aps.anl.gov), or contact Polarization Studies Group leader, George Srajer, at [srajerg@aps.anl.gov](mailto:srajerg@aps.anl.gov).

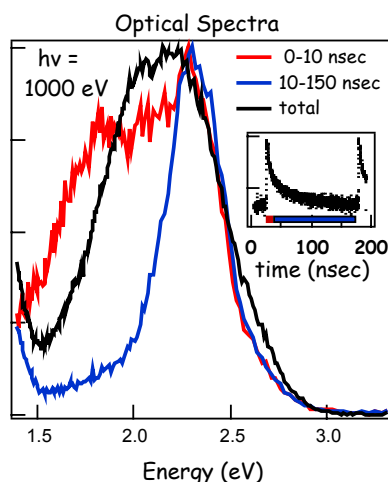
## Research Highlights

*In this issue we present results of two experiments which take full advantage of soft x-rays and in-line polarization capabilities available at sector 4. First, a time-resolved x-ray excited luminescence measurement (4-ID-C) demonstrates a means for studying the dynamics of electronic states involved in the optical luminescence process. The second experiment, done on 4-ID-D, utilizes a resonant scattering technique to observe small induced magnetic moment in nonmagnetic metal layers within a multilayer film.*

### TIME-RESOLVED X-RAY EXCITED OPTICAL LUMINESCENCE

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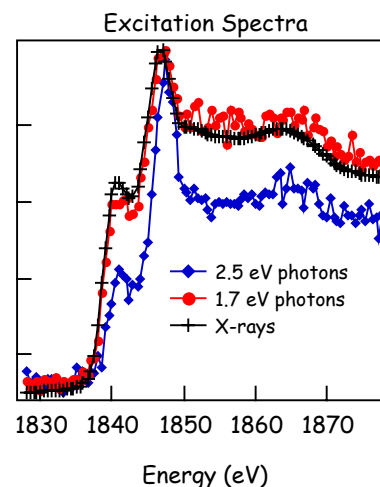
X-ray excited optical luminescence (XEOL) provides the capability to chemically map the sites responsible for producing low energy (1-6 eV) fluorescence. By taking advantage of the time structure of the x-ray pulses at APS (~200 ps wide, 153 ns separation) it is also possible to determine the dynamic behavior of the states involved in the luminescence. In this example we show how this technique can be utilized to understand the XEOL from silicon nanowires.



photons, while the short lifetime component is shifted more to lower energies.

The chemical identity of these states is revealed by excitation spectra at the Si(K) edge. The total ab-

The total optical luminescence spectrum of silicon nanowires following 1000 eV irradiation is shown by the black curve, while the red and blue curves are the spectra with time gates of 0-10 nsec and 10-150 nsec, respectively. The inset shows a typical fluorescence decay curve. These spectra demonstrate that the longer lifetime component is preferentially produced by higher energy photons.



sorption (x-rays, black curve) shows peaks at 1840.5 and 1847 due to Si in the core of the wire and oxidized Si located on the shell, respectively. The yield of low energy (1.7 eV) photons resembles that of the x-rays while the yield of higher energy (2.5 eV), long life-time photons shows an enhancement following excitation of oxide states. Work done in collaboration with Gopal Shenoy and T.K. Sham.

## MEASUREMENTS OF RXMS FROM MAGNETIC POLARIZATIONS INDUCED IN NONMAGNETIC METAL LAYERS

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Indirect exchange coupling in layered magnetic/nonmagnetic metal structures is a long-standing issue, still lacking a clear understanding. The previous XMCD measurements observed weak magnetic polarizations of thin Cu layers in multilayered Co/Cu and Fe/Cu systems. We have profited from the element specificity of resonant x-ray magnetic scattering (RXMS) in a successful observation of resonant superlattice Bragg peaks from a Co(1.3)/Cu(1.9 nm) multilayer at the Cu *K* edge. Panel (a) in the figure below shows the 1st-, 2nd-, and 3rd-order peaks, which are less than  $4 \times 10^{-4}$  in flipping ratio, indicating positive or negative profiles depending on the reflection order. This suggests that the *4p*-states of Cu sandwiched between ferromagnetic Co layers are nonuniformly spin polarized along the out-of-plane direction. In contrast, all three peaks show a same polarity in panel (b), observed from the same sample at the Co *K* edge. The latter profiles are well fit by a calculation assuming a uniformly magnetized Co layers (solid line). The sample studied is located at the third peak of the coupling oscillation, on which a saturation field was externally applied. Scattering studies of indirect exchange coupling now come within range.

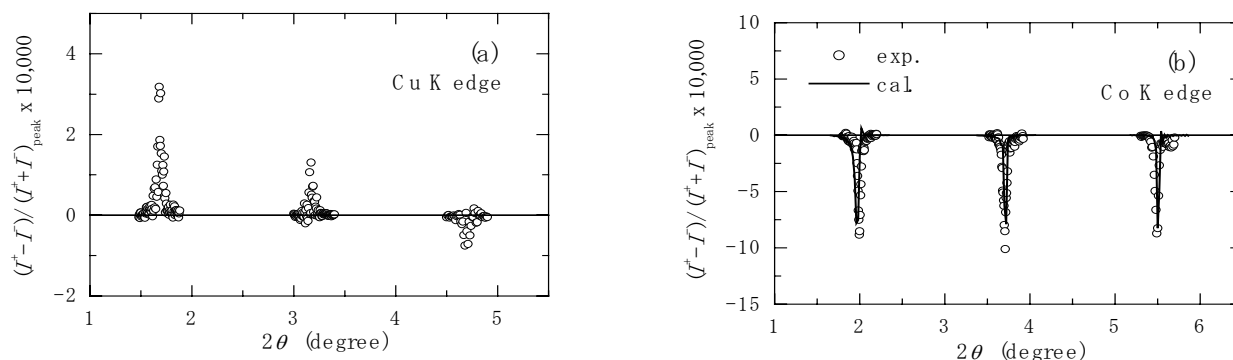


Figure: The raw  $I^+ - I^-$  data include  $\sim 90,000$  photon counts at the top of the 1st peak in Fig. (a), which were measured in 60 s. The actual count rate was  $\sim 3 \times 10^6$  counts/s for  $I^+$  and  $I^-$ , which was made feasible using a photodiode detector. The three peaks in panel (a) were scanned in 400 min, which can be reduced to a few hours by counting  $I^+$  and  $I^-$  at low  $10^7$  cps.

